Variability of the Kuroshio in the East China Sea, and its Relationship to the Ryukyu Current

Mark Wimbush
Graduate School of Oceanography
University of Rhode Island
Narragansett, RI 02882-1197
phone: 401-874-6515 & 401-874-6176 fax: 401-875-6728 e-mail: mwimbush@gso.uri.edu

D. Randolph Watts
Graduate School of Oceanography
University of Rhode Island
Narragansett, RI 02882-1197
phone: 401-874-6507 fax: 401-875-6728 e-mail: rwatts@gso.uri.edu

William J. Teague
Naval Research Laboratory
Stennis Space Center, MS 39522
phone: 228-688-4734 fax: 228-688-5997 email: teague@nrlssc.navy.mil

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LONG-TERM GOALS

To characterize and understand the dynamics of the time varying structure and transport of the Western Boundary Current (WBC) system at 26˚-28˚N in the northwest Pacific Ocean, in particular the Kuroshio in the East China Sea (ECS), and (with our Japanese colleagues) the Ryukyu Current.

OBJECTIVES

Our main objectives are the following:

(1) To observe the WBC variations near Okinawa on all relevant timescales, and, with ancillary information on wind forcing and arrival of offshore eddies, address a comprehensive set of hypotheses that have been proposed to account for the WBC structure and variability:

- that combined WBC mean transport balances the average Sverdrup transport;
- that phasing of the annual cycle in transport is lagged in a predictable manner from the seasonally varying Sverdrup transport, by the propagation of wind-generated Rossby waves from offshore;
- that variability in how the Kuroshio bifurcates upstream (off Taiwan) governs the proportion of transport entering either the ECS Kuroshio or the Ryukyu Current;

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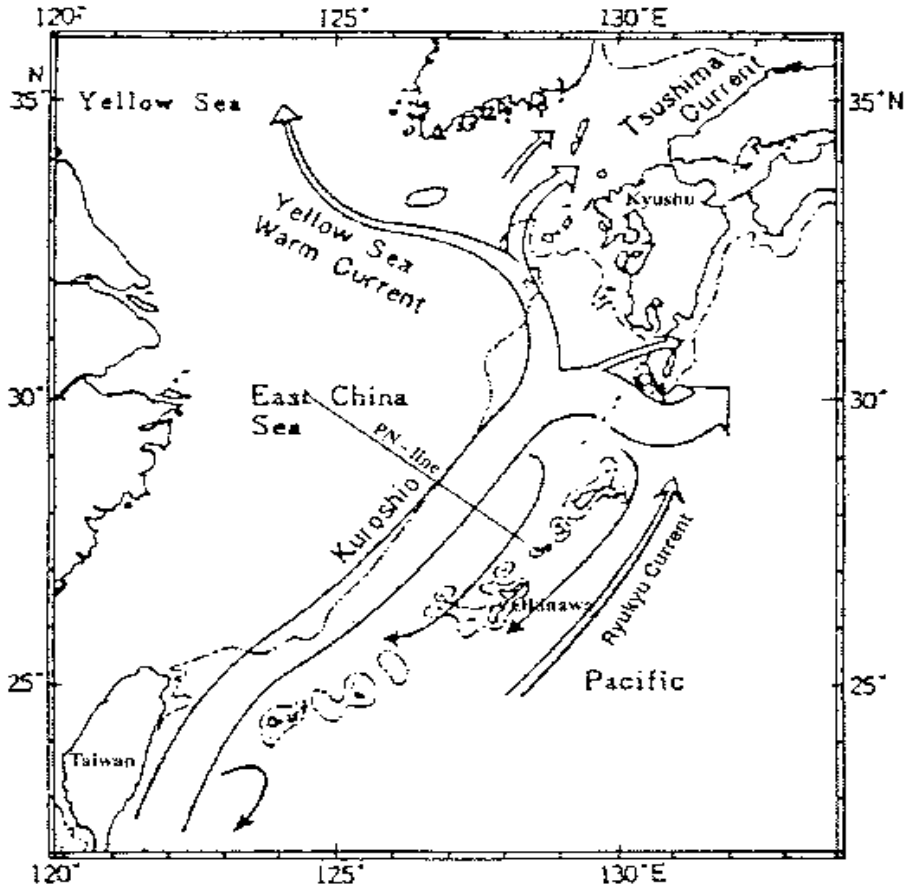
- that eddies arriving at this WBC system from the ocean interior affect the upstream bifurcation and—as a result—the strength of these two currents.

(2) To measure the characteristic periods and phase speeds of Kuroshio meanders in the ECS and relate them to the strength of the transport.

(3) To investigate the relationship between the transports of the ECS Kuroshio and the Tsushima Current.



Schematic representation of the Western Boundary Current system near the Ryukyu Islands, including the Kuroshio and the Ryukyu Current, based on Nitani (1972).

APPROACH

In conjunction with NRL, we will deploy an array of instruments in the Okinawa Trough to measure the time-varying current and temperature structure over a two-year time period, simultaneous with similar measurements to be made by other Japanese scientists at the Japan Marine Science and Technology Center, Frontier Observational Research System for Global Change (JAMSTEC). The instruments will be inverted echo sounders with additional sensors.

To determine temperature and specific-velocity-anomaly profiles from the inverted-echo-sounder measurements, we will use the Gravest Empirical Mode (GEM) technique (Meinen and Watts, 2000), which has been successfully applied to the Kuroshio 700 km further downstream (Book et al., 2002).

WORK COMPLETED

Under ONR (DURIP) support, we first modified our inverted echo sounder design to incorporate the Aanderaa 3820R current measuring head, and then, after field testing, began construction of 12 CPIES instruments (current-and-pressure-sensor-equipped inverted echo sounders). Six of these, together with five PIES instruments (pressure-sensor-equipped inverted echo sounders) belonging to NRL, will be deployed in the ECS in December this year. This deployment will be carried out in conjunction with Dr. Hiroshi Ichikawa and his associates from JAMSTEC on their ship, *R/V Yokosuka*. On the same cruise our JAMSTEC colleagues will deploy a similar array under the Ryukyu Current, on the opposite side of the Ryukyu Island chain. We will take hydrocasts at all deployment sites after the instruments are deployed.

RESULTS

The results from a one-month comparison test in Spring 2002 off Bermuda, show good agreement between current data obtained from the CPIES and those obtained from a conventional current-meter moored about one kilometer away.

The CPIES and PIES instruments will not be recovered until about December 2004, so the data obtained by them will not be available until after that date.

IMPACT/APPLICATIONS

The results from this study should lead to advances in our understanding of WBC dynamics, in particular the dynamics associated with spatiotemporal variability of meanders and bifurcations. This knowledge should be applicable to the Kuroshio at other latitudes, and also to other WBC's.

TRANSITIONS

Since our work is at a preliminary stage, others are not yet able to make use of our work on this project.

RELATED PROJECTS

The JAMSTEC "Kuroshio Obervation Project" (KOP) focuses on understanding the barotropic and baroclinic components of the WBC on either side of Okinawa, in the Ryukyu Island Chain. The

JAMSTEC KOP array is on the eastern side of Okinawa, under the Ryukyu Current. Our array will be on the western side in the ECS.

The "Kuroshio Extension System Study" (KESS) is an NSF-supported collaborative study of the region 2,000 km downstream of our ECS area. As part of the KESS study, we will deploy a large array of CPIES instruments (including several built under the DURIP grant) to study the dynamics of that region. The array will be in place for two years beginning in Spring 2004.

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